

➔ REPORT NO : SCNZ 111 : 2018

NEW ZEALAND GUIDE TO THE SOURCING OF COMPLIANT STRUCTURAL STEELS



New Zealand Guide to the Sourcing of Compliant Structural Steels

Report: SCNZ 111:2018

Authors:

Alistair Fussell
SCNZ

Kevin Cowie
SCNZ

Stephen Hicks
HERA

Michail Karpenko
HERA

A copy of this report is downloadable from the SCNZ website. See www.scnz.org.

Published by:
Steel Construction New Zealand Inc.
17-19 Gladding Place
PO Box 76403
Manukau City 2241
New Zealand
Phone: +64 9 2635 635
Fax: +64 9 2622 856

Copyright © Steel Construction New Zealand Inc. 2018

No portion of this report may be copied or reproduced in any form or by any means without the written permission of the Steel Construction New Zealand Inc.

ISBN: 978-0-473-44546-1

Steel Construction New Zealand Inc.(SCNZ) is a member-based, not-for-profit society incorporated under the Incorporated Societies Act 1908.

Steel Construction New Zealand Inc.(SCNZ) has three basic objectives:

- To promote awareness of the advantages of steel construction
- To promote excellence in the delivery of steel construction solutions
- To encourage training and career development within the steel construction sector

Disclaimer of Warranty

Although we will strive to maintain the accuracy and usefulness of this report and update it regularly, you should be aware of the following constraints affecting the material contained in this report:

1. The report includes content provided by third parties and users. Parts of the material are drawn from third-party publications and research. If they publish the wrong data or quote inaccurately, then the material in this report could also be wrong. To combat this, we endeavour to update our data regularly and invite publishers to correct any incorrect data. SCNZ makes no warranty as to the completeness, accuracy, currency, or reliability of information published in this report.
2. The report is not comprehensive nor contains all information that may be relevant. Content provided in this report is a guideline and is only intended to facilitate understanding between you and your structural engineer. We provide no warranty or guarantee for any information provided by the report or by any other form of communication. Content is not intended to provide calculations for your project and is not a substitute for professional advice.
3. Any opinions, advice, statements, services, offers or other information expressed or made available by third parties are those of the respective authors or distributors of such content and not of SCNZ.

You acknowledge, by your use of this report and your use of its material is at your sole risk that you assume full responsibility for all risk associated with any of your use of the material, including responsibility for all costs associated with all necessary advice you take in connection with your use of the material.

Limitation of Liability

We shall not be liable – whether in contract, tort or otherwise – for any consequential, indirect or special damage or loss of any kind whatsoever suffered by you in connection with you using or relying upon this report or its content.

Changes to Content

We reserve the right to make changes to the report and the policies and conditions that govern the use of the report at any time. We encourage you to review our web site and the terms of this report regularly for any updates or changes. Your continued access to our website and use of the report shall be deemed your acceptance of these changes and the reasonableness of these standards for notice of changes.

Document Control

Revision History			
Revision	Date	Description	Prepared by
0	29/09/2017	For HERA review	AJF
1	27/10/2017	Added Appendix F & G and various amendments post HERA review.	AJF
2	18/12/2017	Final SCNZ and HERA review before stakeholder consultation	AJF
3	20/12/2017	Stakeholder review document	AJF
4	June 2018	Updated following stakeholder review process	AJF

Table of Contents

1.0 Introduction	11
1.1 Purpose	11
1.2 Scope of this Guide	11
1.3 Who Should Use this Guide?	11
1.4 Abbreviations	11
1.5 Definitions	12
2.0 The New Zealand Structural Steel Industry	13
3.0 Product Conformity and Design Standards	14
3.1 Introduction	14
3.2 Regulating Product Quality	14
4.0 Conformity Assessment and Product Standards	15
4.1 Introduction	15
4.2 Product Conformity Requirements - AS/NZS Structural Steel Standards	15
5.0 Third-Party Conformity Assessment Pathways	16
5.1 Introduction	16
5.2 Accreditation of Conformity Assessment Bodies	16
5.3 Factory Production Control Certification	17
5.4 Third-Party Product Certification Schemes	17
5.5 Verification Testing	18
5.6 Quality Control Criteria and Acceptance Rules	19
6.0 Selection of Conformity Assessment Pathways	22
6.1 Introduction	22
6.2 Conformity Assessment Pathway Selection	22
6.3 Key Elements of Conformity Assessment Pathway Selection Framework	23
6.4 Evidence of Conformity	23
7.0 Further Reading	24
8.0 Recommended Procurement Practice	25
9.0 Conclusions	26
References	26
Appendix A - List of AS/NZS Structural Steel Product Standards	27
Appendix B - Conformity Assessment Pathway Selection Framework Diagrams	29
Appendix C - AS/NZS 5131 Construction Categories	33
Appendix D - Batch Testing and Inspection	35
Appendix E - Statistical Sampling as a Means of Demonstrating Conformity	39
Appendix F - Source Reliability Categories	41
Appendix G - Implementation of Conformance Assessment Pathway Selection Framework	43
Appendix H - Determine evidence of conformity to accept batches of steel – Worked examples	45
Appendix I - Summary of Recommended Source Reliability Conformity Requirements	49

1.0 Introduction

1.1 Purpose

With the globalisation of structural steel supply chains for New Zealand building and infrastructure projects, more robust procurement practices are required to demonstrate product conformity than are currently stipulated in the relevant material supply standards and the New Zealand Building Regulations.

Recognising this reality, SCNZ has developed the New Zealand Guide to Sourcing Compliant Structural Steels in collaboration with HERA. The intention is that this document will simplify and unify practice for demonstrating conformity of structural steels in New Zealand.

The key element of this Guide is a risk-based conformity assessment pathway selection framework that considers both project (consequence of failure) and supplier (reliability/capability) risk. This framework has been presented diagrammatically for structural steels to be used in locally and internationally fabricated structural steelwork. The purpose of the selection framework is to determine what evidence of conformity is required based on a consideration of project and steel source risk. In particular, it will identify if project specific third-party testing is warranted.

To provide a context for the conformity assessment framework, an overview is provided of the local structural steel industry and the product conformity requirements specified in the suite of AS/NZS structural steel supply standards (SA/SNZ, 2016).

1.2 Scope of this Guide

This Guide covers the supply of structural steels (long and plate products) and welded sections for locally and internationally fabricated structural steelwork.

This Guide only covers welded sections manufactured to AS/NZS 3679.2.

1.3 Who Should Use this Guide?

This Guide has been prepared to assist all stakeholders engaged in the design (Engineers), construction (Builders, Fabricators, Steel Distributors) and consenting (Building Consent Officials and Building Regulators) of structural steel buildings and infrastructure projects.

1.4 Abbreviations

ACRS	Australasian Certification Authority for Reinforcing and Structural Steels
APCC	Australasian Procurement and Construction Council
AS	Standards Australia
ATIC	Australian Technical Infrastructure Committee
BSI	British Standards Institution
CAB	Conformity Assessment Body
FPC	Factory Production Control
IAF	International Accreditation Federation
ILAC	International Laboratory Accreditation Cooperation
ITT	Initial type testing
JAS-ANZ	Joint Accreditation System of Australia and New Zealand
MLA	Multilateral recognition arrangement
MRA	Mutual recognition arrangement
NZS	Standards New Zealand
SDOC	Supplier declaration of conformity
SFC	Steel Fabrication Certification Scheme
UK CARES	UK Certification Authority for Reinforcing Steels

1.5 Definitions

For the purpose of this Guide, the following definitions apply:

Fabricated Structural Steelwork

Structural steel that has been cut, bent and assembled by welding or bolting to a set design.

Imported Fabricated Structural Steelwork

Fabricated structural steel that has been fabricated overseas and subsequently imported.

Structural Steels

Steel material of various shapes and grades used in construction applications. This is the raw material from which fabricated structural steelwork is manufactured. With the exception of some plate, structural steel is produced overseas and imported as a 'raw' product to be fabricated in New Zealand.

Structural Steel Contractor

Manages the whole structural steelwork process from shop drawing to manufacture and completion of the erected structure.

Supplier

The distributor, stockist or importer supplying the structural steel material or component.

2.0 The New Zealand Structural Steel Industry

The local structural steel sector is a value-adding industry with an annual capacity of circa 110,000 tonnes. Approximately 80% of this output is produced by structural steel contractors certified under the Steel Fabrication Certification (SFC) scheme (<http://steelfabcert.co.nz>).

This sector consists of over 80 specialist structural steel contractors and general engineering companies that typically manage contracts from procuring materials, fabricating and coating (if required) to the final erection of the structure.

Structural steels used in local projects will typically be imported through Steel Distributors who will either supply product ex stock or indent steels for specific projects. Historically, structural steels have come from Britain, USA, Australia and New Zealand. The New Zealand Steel mill which produces flat products (plate and coil) was constructed in the late 1960s. In the past quarter century, the origin of steels used in New Zealand has broadened to include Japan, Korea, Taiwan and Thailand. More recently steels of Chinese, Malaysian and Indonesian origin (primarily plate and hollow sections) have been supplied through local steel distribution companies.

All the structural steel mills supplying hot-rolled sections to New Zealand and some of the plate and structural hollow section manufacturers have third-party certification for their range of product supplied to AS/NZS structural steel standards.

The practice of sourcing fabricated steelwork offshore has grown recently. Initially, imported structural steel was limited to low-rise industrial projects, but in the past few years fabricated structural steelwork used in several major commercial projects has been supplied by offshore fabrication companies. There are inherent risks associated with sourcing offshore fabricated structural steelwork, which needs to be taken into consideration when approved for use by consulting professionals and territorial authorities.

3.0 Product Conformity and Design Standards

3.1 Introduction

The design equations in limit state standards such as the Structural Steel Standard NZS 3404 (SNZ, 1997), are calibrated to ensure an acceptably low probability of failure. This calibration exercise considers, amongst other things, members being understrength due to variation in material strength and section properties. To ensure the design assumptions in the calibration exercise remain valid, the structural steels produced by manufacturers must meet long-term minimum, or in some cases maximum values, also known as long-term quality levels. To achieve these long-term quality levels, the manufacturer will target a mean value of material property higher than the minimum target value to allow for production variability, see figure 1. A batch test only affords a snap shot of the manufacturer's production at a point in time, it does not give any indication of long-term quality levels. A statistical approach utilising test data collected over a period of time is required to determine this.

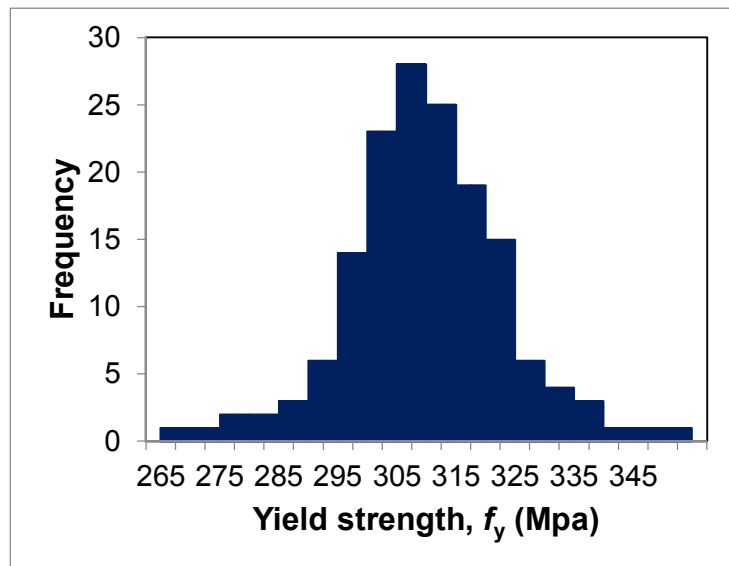


Figure 1 – Yield strength histogram based on manufacturer production testing – Grade 250 steel
Graph courtesy of Heavy Engineering Research Association (HERA)

3.2 Regulating Product Quality

The conformity requirements in the AS/NZS structural steel standards to regulate product quality are discussed in section 4.0.

4.0 Conformity Assessment and Product Standards

4.1 Introduction

Structural steel supply standards will typically include product conformity and conformity assessment requirements. Conformity requirements include specification of the characteristics of the product e.g. minimum yield stress and the inspection and test requirements for checking conformity of the product to the requirements of the standard. Conformity assessment involves the series of processes necessary to show a product meets the requirements of the standard.

The main forms of conformity assessment are inspection/testing (determination), review of the evidence of determination and attestation (statement of conformity). Conformity assessment also interacts with other fields such as quality management. It is essential that a manufacturer operates a quality management system in conjunction with its conformity assessment activities, to ensure it consistently meets the requirements of the relevant supply standard.

4.2 Product Conformity Requirements - AS/NZS Structural Steel Standards

The product conformity requirements in the latest AS/NZS material supply standards have taken inspiration from those found in EN product standards. These standards are listed in Appendix A. Specifically, manufacturers of steel products to these standards are required to meet the following requirements (Hicks, 2016):

- Initial Type Testing (ITT): The complete set of tests described in a standard to determine the characteristics of samples of product representative of the product type. The ITT provides the manufacturer with the characteristics of the product using their manufacturing, measuring and quality management system (QMS).
- Factory Production Control (FPC): Operational techniques and all measures necessary to maintain and regulate the conformity of the product to the requirements of the relevant standards, which ensures that performance declared by the manufacturer (through ITT) continue to be valid for all subsequent products. This includes personnel, equipment, procedures and inspection and testing.

An important point to note is that Standards Australia and Standards New Zealand adopt the principle of neutrality for their standards documents. Under this principle conformity assessment can be first (manufacturer), second (purchaser) or third-party (independent party).

5.0 Third-Party Conformity Assessment Pathways

5.1 Introduction

In New Zealand the role of third-party Conformity Assessment Bodies (CABs) is not covered by building regulations, it is left up to engineers and/or territorial authorities to make this assessment and to specify any particular requirements in the design documentation or Building Consent conditions.

A risk-based approach is recommended to determine if the use of a third party in the product conformity assessment process is warranted and, if it is, what role it will play. Such a risk-based approach should consider the consequences of failure of a non-compliant product and the reliability of the mill.

There are several conformity pathways that utilise the services of third-party conformity assessment bodies. These include:

1. Factory Production Control (FPC) certification
2. Product certification
3. Project-specific verification testing (statistical and non-statistical quality control)

Each of these pathways, to varying degrees, provide better evidence that product conforms to the required standard than is afforded by first-party (manufacturer) conformity assessment alone. These conformity assessment pathways are discussed in detail in sections 5.3 to 5.5.

5.2 Accreditation of Conformity Assessment Bodies

Accreditation is an important element of the conformity assessment infrastructure. It is third-party recognition of the competency and independence of conformity assessment bodies in the fields of testing, calibration, inspection and certification (Product and Quality Management Systems).

Such accreditation bodies also need to demonstrate their own competency and independence to ensure their activities are recognised in other countries. For this reason, accrediting bodies are often established as national or regional entities that enter in mutual recognition arrangements through membership of relevant international bodies that peer review each other (ISO/ UNIDO).

The key international bodies in the fields of testing and calibration, and certification are the International Laboratory Accreditation Cooperation (ILAC) and the International Accreditation Forum (IAF) respectively. For further information on these organisations and mutual recognition arrangements, reference can be made to their websites, see table 1.

Field of interest	Organisation	Website Address
Testing and calibration	International Laboratory Accreditation Cooperation (ILAC)	http://ilac.org/
Product and Quality Management System Certification	International Accreditation Forum (IAF)	http://www.iaf.nu/

Table 1 – International Accreditation Organisations

The national accrediting bodies in Australia and New Zealand relevant to structural steel procurement are noted in table 2.

Field of interest	Organisation	Country	Website Address
Testing and calibration	International Accreditation New Zealand (IANZ)	New Zealand	http://www.ianz.govt.nz/
	National Associations of Testing Authorities (NATA)	Australia	https://www.nata.com.au/
Product and Quality Management System Certification	Joint Accreditation System of Australia and New Zealand (JAS-ANZ)	Australasia	http://www.jas-anz.org/

Table 2 – Australasian National Accrediting Bodies

An important point to note is that conformity assessment bodies must operate within the scope of their accreditation. The scope of accreditation of a CAB is typically available through the website of the relevant national accreditation body. To search for ILAC MRA signatories by country, visit <https://ilac.org/signatory-search/>.

5.3 Factory Production Control Certification

5.3.1 About

As discussed in section 4.2, FPC consists of operational techniques and all measures necessary to maintain and regulate the conformity of the product to the requirements of the relevant standards and ensures that the performance declared by the manufacturer (through ITT) continue to be valid for all subsequent products.

FPC certification involves an initial inspection of the factory and their ITT, followed by their FPC. This will be followed by annual surveillance audits to maintain certification.

5.3.2 Limitations and Requirements

FPC certification is an indication of capability of the steel manufacturer or tube maker to consistently produce product to the required standard. However, FPC Certification, be it first or third party, does not provide independent verification that any product produced by a manufacturer complies with a particular standard.

5.3.3 Examples

European Construction Product Regulations define the degree of involvement of a third party (Notified Bodies) in assessing the conformity of structural steels manufactured to EN product standards. The key role for a Notified Body is auditing and certifying that the FPC system of the manufacturer meets the requirements of the relevant product standard (Annex ZA). For a list of accredited notified bodies, refer to the following internet address: <http://ec.europa.eu/growth/tools-databases/nando/>.

Taking inspiration from European practice, the Singapore Building Construction Authority (BCA) has developed similar FPC system requirements which are documented in the Singapore BCA publication, Design Guide on Use of Alternative Structural Steel to BS 5950 and Eurocode 3 (Singapore BCA, 2012). The Singapore BCA has recognised various conformity assessment bodies as qualified to audit and certify manufacturer FPC systems. The BCA document covers a wide range of structural steels manufactured to AS/NZS, JIS, ASTM, KS (Korean) and GB (Chinese) product standards. A similar methodology to the BCA publication has also recently been developed for Hong Kong and Macau (HKCMSA-P001,2015).

An example of an industry developed pipe manufacturer quality management system programme is API Monogram Licencing (<http://www.api.org/products-and-services/api-monogram-and-apiqr>).

5.4 Third-Party Product Certification Schemes

5.4.1 About

The most rigorous approach to product conformity assessment is third-party product certification under a robust product certification scheme. In addition to auditing the manufacturer's quality management system (FPC), independent testing of product is undertaken. This type of conformity assessment provides the simplest

evidence of compliance for all parties. The CAB will issue some form of statement of product conformity such as a product certification certificate. Such certificates should clearly state the scope of the certification.

5.4.2 Limitations and Requirements

The rigor of the scheme is determined by the scheme owner. In particular, consideration should be given to the independent test requirements (e.g. how much, how often and are the results assessed statistically to make decisions about product conformity?). The scheme should meet the requirements of ISO 17067 – Conformity assessment – Fundamentals of Product Certification and Guidelines for Product Certification Schemes (ISO, 2013) and the CAB should be accredited by a signatory to the International Accreditation Forum Multilateral Recognition Arrangement (e.g. JAS-ANZ in New Zealand and Australia).

5.4.3 Examples

Third-party product certification schemes for structural steels have been developed by standards associations, industry and CABs. Some examples of such schemes are presented in table 3.

Originator	Third-party Certification Scheme
Industry	ATIC (Australian Technical Infrastructure Committee) scheme 10
Standards Association	JIS Mark (Japanese Industrial Standards) Benchmark BSI
Conformity Assessment Bodies	ACRS Scheme (Reinforcing and Structural Steels to AS/NZS standards) BSI (Reinforcing and Structural Steels to EN standards) BSI Benchmark (Reinforcing and Structural Steels to AS/NZS standards) UKCARES (Reinforcing and Structural Steels to EN standards)

Table 3 – Examples of third-party certification schemes

5.5 Verification Testing

5.5.1 About

Verification testing is the independent assessment of selected mechanical and chemical properties of a test sample. Such testing should be undertaken by a suitably accredited test facility. The sample or samples will be taken from a batch or lot of product intended for use in a building or infrastructure project. A batch can represent up to 200 tonnes of product. The procurer or the project designer needs to specify the material properties to be assessed, the sampling plan and the basis on which decisions about the quality of batches of product will be made (pass/fail or statistical sampling).

Testing should be undertaken by test facilities accredited by signatories to the International Laboratory Accreditation Co-operation's (ILAC's) Mutual Recognition Arrangement (MRA). The scope of accreditation should include the specific tests required in the relevant material supply standard. In New Zealand and Australia, the national accrediting bodies are International Accreditation New Zealand (IANZ) and the National Association of Testing Authorities (NATA) respectively. To check the scope of test facility accreditation, reference can be made to the website of the relevant accrediting body.

Note, in parts of Asia, test facility accreditation is no guarantee of reliable test results. If there are concerns about the reliability of an offshore test facility utilised for project specific third-party testing, it is recommended a duplicate set of samples is collected. One set of samples is sent to the offshore test facility while the second is sent to New Zealand. A robust sample collection process and tracking system involving a trusted third party is advisable. A small percentage of the samples sent to New Zealand can be tested (10-20% suggested). It is recommended a qualified metallurgist review the two sets of test results and advise if additional New Zealand testing is warranted.

5.5.2 Sampling and Testing Plans

The key elements of sampling and testing plans are the sample size per batch of steel and the acceptance criteria. The acceptance criteria will be dependent on the quality control approach – statistical or non-statistical. These quality control approaches are discussed in section 5.6.

It is recommended that project-specific verification testing focus on the key material properties that affect the performance of steel structures. This includes mechanical properties and chemical composition.

Two sampling and testing plans have been prepared for use in conjunction with the conformity assessment pathways recommended in this Guide, refer Appendix D. These plans are defined as sampling and testing plan (standard), and sampling and testing plan (premium). The primary difference is the batch acceptance criteria. The standard plan features a simple non-statistical pass/fail criteria for the material properties assessed by inspection or testing. In contrast, the premium plan features a mix of batch acceptance approaches. Some properties are assessed utilising a non-statistical approach while others are assessed with a statistical sampling (sampling by variables) approach. These plans are summarised as follows:

Sample and Test Plan	Characteristic	Requirement	Batch acceptance approach
Standard	Mechanical properties	Yield strength, tensile strength, elongation	Non-statistical (pass/fail)
		Impact toughness	Non-statistical (pass/fail)
	Chemical composition	Product analysis	Non-statistical (pass/fail)
	Tolerances	Out of straightness	Non-statistical (pass/fail)
	Weld quality	Cold flattening or flange/web tension test (only required for hollows and welded sections)	Non-statistical (pass/fail)
Premium	Mechanical	Yield strength, tensile strength, elongation	Statistical - Sampling by variables (refer Appendix E)
		Impact toughness	Non-statistical (pass/fail)
	Chemical composition	Product analysis	Non-statistical (pass/fail)
	Tolerances	Out of straightness	Non-statistical (pass/fail)
	Weld quality	Cold flattening or flange/web tension test (only required for hollows and welded sections)	Non-statistical (pass/fail)

Table 4 – Sampling and testing plans for use in conjunction with the conformity assessment pathways recommended in this Guide.

To determine if project-specific verification testing is recommended to demonstrate conformity of batches of steel, refer Appendix B.

NB: This project-specific third-party testing is intended to complement production testing undertaken by the manufacturer.

5.6 Quality Control Criteria and Acceptance Rules

5.6.1 Introduction

Once project-specific verification testing and inspections have been undertaken, a conformance assessment body on behalf of the supplier will need to make decisions about the conformity of batches of steel based on the information collected. The approach used to make these decisions will be driven by several factors. These include risk, cost and time. In this section three quality control approaches are discussed, including the rationale for the approaches recommended in this Guide.

Quality control of the manufacture of construction materials is important to ensure assumptions made in developing limit state design standards such as the Steel Structures Standards remain valid. This is recognised in ISO 2394 – General Principles on Reliability for Structures (ISO, 2015). In this document an Appendix section is dedicated to guidance on quality management, quality assurance and quality control. Quality control involves the following actions (ISO, 2015):

- Collection of information
- Judgement based on information
- Decision based on judgement

Two approaches to quality control are presented in ISO 2394:

1. Total
2. Statistical

A third approach commonly used is:

3. Non-statistical

The third approach is not discussed in ISO 2394. The reason for this is the lack of statistical rigor in this approach.

Each of these approaches are discussed in sections 5.6.2 to 5.6.4.

5.6.2 Total Quality Control

About

Every product is inspected. A product is judged as being good (accepted) if it meets the criterion (eg tolerances) and bad (not accepted) if it does not meet the criterion.

Limitations

This approach is too expensive and time consuming to implement for the quality control of structural steels. It is not recommended in this Guide.

5.6.3 Statistical Quality Control

About

Statistical sampling is a procedure that enables decisions to be made with respect to the quality of batches of items after inspecting or testing only a portion of those items. This procedure will only be valid if the sampling plan has been determined on a statistical basis (SA/SNZ, 2001).

Two basic methods of sampling inspections applicable for quality control in buildings are:

1. Sampling inspection by attributes and
2. Sampling inspections by variables

These approaches are discussed in ISO 12491 – Statistical methods for quality control of building materials and components (ISO, 1997).

The key elements of statistical sampling are:

1. Preparation of sampling plan
2. Random selection of samples
3. Testing at an appropriately qualified test facility, see section 5.2
4. Statistical judgement of the results (It is recommended a qualified metallurgist is engaged to undertake this task)
5. Decision regarding acceptance

Limitations

Statistical sampling is a more expensive and time-consuming approach to demonstrating the conformity of batches of structural steel than is typically adopted for most structural steel projects. This is due to the amount of testing required and the subsequent statistical analysis of the data.

Examples

There is a statistical sampling methodology for reinforcing and prestressing steels published in AS/NZS 4671 – Steel Reinforcing Materials (SA/SNZ, 2001) and AS/NZS 4672-2 – Steel Prestressing Materials - Testing Requirements (SA/SNZ, 2007) respectively. In these standards, manufacturers are required to undertake batch testing and to determine long-term quality levels for their product based on historic product test data. For reinforcing and prestressing steels to be compliant with this standard, the batch test results and the long-term quality levels need to comply with those specified in the standard.

If the steels are not covered by long-term quality levels, a more onerous batch-testing regime and subsequent statistical analysis is required. The conformity requirements feature inspections by variables (yield stress, tensile strength, tensile-to-yield ratio and elongation) and inspection by attributes (behaviour in rebend test, tolerances, projected rib or indentation area, or bond test).

A statistical sampling inspection by variables approach as a means of demonstrating product conformity for batches of structural steels is presented in Appendix E. This methodology is based on the principles of ISO 12491. In this Guide it is recommended to only use this approach to make judgements about the tensile properties of batches of structural steels for high-risk projects, see Appendix B.

5.6.4 Non-Statistical Quality Control

This is the most commonly used approach to making decisions about the conformity of batches of steel utilising the results of project-specific third-party testing. The advantages of this approach are its simplicity and cost.

About

The non-statistical approach presented in this Guide has similarities to sampling inspections by attributes. The requirements of this approach are:

- The number of samples (n) to be collected must be specified
- The properties of interest to be inspected or tested must be defined e.g. mechanical properties (yield stress, tensile strength, elongation)
- A sample is deemed conforming if the properties inspected and tested meet the requirements of the relevant product standard
- The acceptance rules state the number of non-conforming products (z) in a sample size of n that are permissible (A_c). A batch is acceptable if $z \leq A_c$

The significant departure of the non-statistical quality control approach from sampling by attributes is the required sample size. Depending on the producer and consumer risk, the number of samples per batch could be between 20 and 1,000. Producer and consumer risk is discussed in ISO 12491 (ISO, 1997). This document also includes tables that specify the sample size and the acceptance number, A_c . In the non-statistic quality control approach presented in this Guide, the number of samples per batch of steel for most mechanical, chemical and geometric properties is one and the acceptable number of defects per batch (A_c) is zero. The recommended sampling plans, which feature mostly non-statistical quality control are presented in Appendix D.

Limitations

While third-party, non-statistical quality control provides increased confidence about the quality of batches of steel, it does not represent a sound basis for making decisions about product quality when the project risk is high and this is only form of third-party product conformity assessment utilised.

Summary of Quality Control Approach Recommended in the Guide

In this Guide, the assumption has been made that manufacturers who have third-party certified product or FPC, have the appropriate manufacturing controls to regulate the long-term quality levels of their production. Therefore, third-party, non-statistical quality control is acceptable where project-specific testing is required.

Conversely, if a manufacturer has no third-party certified FPC or product certification, the product is deemed to not be covered by long-term quality level. In this instance, a statistical quality control approach, inspection by variables presented in Appendix E is recommended to make judgements about the tensile properties of batches where project-specific testing is required.

6.0 Selection of Conformity Assessment Pathways

6.1 Introduction

A risk-based conformity assessment pathways selection framework has been prepared for locally and internationally fabricated structural steelwork. This is presented diagrammatically, see Appendix B.

The framework has been based on local and international practice including the risk-based consenting practice of a New Zealand City Council.

6.2 Conformity Assessment Pathway Selection

A risk-based approach to conformity assessment for structural steels needs to consider project and supply risk. Project risk includes the consequence of failure and the complexity of the construction works. This is addressed in the recently published risk-based Structural Steelwork – Fabrication and Erection standard (AS/NZS 5131 (SA/NZS, 2016)). This standard recognises four construction categories. These construction categories have been utilised in the conformity assessment pathway selection framework. Examples of the construction categorisation of various types of structures are presented in Appendix C.

The supply risk relates to the reliability of the product and this is based on the manufacturer and the chain of custody of steel products from the mill, to the fabrication workshop, and then to site.

The conformity assessment pathway selection framework is based on the following principles:

- a. The conformity assessment options are ranked in order from least to most robust as follows: 1. First-party (manufacturer), 2. Third-party FPC Certification, 3. Third-party Product Certification.
- b. The risk of non-compliance is reduced if the steel mill or tube maker is a regular supplier to the New Zealand market. Over a period of time there is the opportunity to monitor supplier performance (periodic testing) and to clearly communicate supply expectations in terms of quality.
- c. It is vital product traceability is maintained through the whole supply chain. This becomes more challenging for offshore fabricated structural steelwork due to the loss of product markings (bundle or individual products) by the time the fabricated components arrive in New Zealand. In this situation it is recommended there are robust sample collection and material traceability processes in place involving trusted third parties. Product traceability is required from the steel mill to the steel fabricator's workshop, through the fabrication process to the site.

If the construction reviewer or the territorial authority have concerns about the test sample collection or material traceability processes, it is recommended the steel is treated as unidentified steel in accordance with the requirements of NZS 3404 (SNZ, 1997). This will involve cutting samples from fabricated structural steelwork for testing when it arrives in New Zealand.

- d. For high-risk projects where project-specific verification testing is required, non-statistical evaluation of conformity is limited to steels produced by manufacturers with some form of independent assessment of capability or product quality (FPC or Product Certification).

The recommended conformity requirements for structural steels by source reliability and construction category are presented in Appendix I.

The conformity assessment pathway selection framework for structural steels is presented diagrammatically in Appendix B.

The diagrams are divided into 3 sections:

1. Risk assessment (based on AS/NZS 5131)
2. Selection of conformity assessment pathway
3. Evidence of conformity associated with each conformity assessment pathway

An additional consideration for internationally fabricated structural steelwork is the use of steel grades not recognised in the Steel Structures Standard (NZS 3404, SNZ, 1997). The use of alternative steel grades requires expert assessment to establish equivalency with a recognised grade of steel. This expert assessment

process is outside the scope of this Guide but would not be limited to only an assessment made by a metallurgist.

6.3 Key Elements of Conformity Assessment Pathway Selection Framework

The key elements to the implementation of the recommended conformance assessment pathway selection framework are:

1. Structural steels must be categorised into source reliability categories based on an assessment of their quality risk. It is recommended this task is undertaken by a qualified metallurgist. The source reliability categories are defined in Appendix F.
2. Assignment of responsibilities to various parties in the structural steel procurement supply chain. A recommended implementation diagram with tasks assigned is presented in Appendix G.
3. The project construction category or categories must be supplied to all the relevant parties in the supply chain. This includes the builder, structural steel contractor and steel supplier.
4. There are two hold points proposed to ensure the structural steels sourced meet the requirements of the Guide. The first is review and approval of the steel source list prior to ordering the steel. The steel source list will include the source reliability category of each manufacturer, if any project specific verification testing is required for the construction category, and what evidence will be provided with steels supplied to the structural steel contractor. The second hold point is to review and approve the evidence of conformity supplied with the steel before fabrication begins. This is illustrated in Appendix G.

6.4 Evidence of Conformity

6.4.1 Introduction

Following the conformity assessment process, documentation is required that consists of a statement of conformity and, in some cases, a test/inspection report which presents the data on which the assessment of conformity was based. This documentation must be traceable to structural steel delivered to the fabrication workshop.

6.4.2 Test Certificate (First-Party)

Steel manufacturers are required to supply product with inspection documentation traceable to product via bundle or individual product markings. The inspection documentation consists of a test report or test certificate issued by a test facility on behalf of the manufacturer. The test facility must be accredited for the relevant test procedures by an ILAC Mutual Recognition Agreement signatory. The required information to be provided on the inspection document is stated in the relevant supply standards.

6.4.3 Third-Party Product or Factory Production Control Certification

The required evidence of third-party product or FPC certification is a valid certificate issued by the CAB. It is important to check that the certification covers the product range of interest.

Certifications can be suspended or revoked, it is therefore recommended the CAB is contacted to ensure the certification is still current.

6.4.4 Verification Testing

The results of verification testing/inspections will be presented in a written report. In addition to test data, the document should include a statement of conformity and an explanation of how the test samples have been collected. See Appendix D for a list of information to be supplied in the verification test report.

It is important that the testing organisation is appropriately accredited for the scope of conformity assessment activities undertaken.

6.4.5 Supplier Declaration of Conformity

Following verification testing, attestation of compliance with the relevant standard shall take the form of a Supplier Declaration of Compliance (SDOC). For details of the SDOC, refer to Appendix D.

7.0 Further Reading

There is good body of publications dedicated to the subject of sourcing compliant construction materials including structural steels. These include those published by local and international structural steel industry associations, various Australian procurement groups and standards associations. Some of the more relevant publications readers may want to consult are listed in table 5.

Title	Organisation	Type of publication	Reference
Evaluation of Product Conformity	Steel Construction New Zealand (SCNZ)	Fact Sheet	www.scnz.org
Structural Steel Product Standards		Fact Sheet	www.scnz.org
Conformity of Structural Steel Products and Structures	Heavy Engineering Research Association (HERA)	SESOC journal article	Volume 29 No 2 September 2016
Ensuring Compliance of Structural Steelwork – Regardless of Origin	SCNZ/HERA	SESOC journal article	Volume 29 No 1 September 2016
Steel Update: Standards and Compliance Initiatives	SCNZ/HERA	Conference paper	2017 SESOC Conference
Third-Party Product Certification	Australian Steel Institute	Technical Note	www.steel.org.au
Procurement of Construction Products – A Guide to Achieving Compliance	Australasian Procurement and Construction Council	Guide	http://www.apcc.gov.au
The Conformity Assessment Toolbox	International Standards Organisation (ISO)	Handbook	www.iso.org

Table 5 – Construction Material Procurement Publications

8.0 Recommended Procurement Practice

The Australasian Procurement and Construction Council publication, Procurement of Construction Products – A Guide to Achieving Compliance (APCC, 2015), has a good summary of procurement principles that, if followed, will reduce the risk of sourcing non-compliant structural steel products. These are reproduced in a slightly modified form to suit a New Zealand context and to reflect the conformity assessment approach recommended in this Guide.

Principle 1

Contract documents should clearly specify product standards and the required evidence of conformity

Principle 2

All products sourced should meet the requirements of the contract documents

Principle 3

The selection of the evidence of conformity should be based on an assessment of the project and supply risk. Such an approach is presented in this Guide (Appendix B)

Principle 4

Evidence that structural steels meet the specified standard should be demonstrated by conformity assessment as specified in this Guide

Principle 5

Evidence of the source of structural steels and their authenticity should be retained

Principle 6

Documented evidence to demonstrate the conformity of the structural steels should be supplied to the relevant parties in the structural steel supply chain (Builder, Structural Steel Contractor, Engineer)

Principle 7

Responsibility for managing conformity assessment outcomes at each stage of the project should be appropriately allocated in the contract documentation

Principle 8

Where third-party CABs are relied upon to provide evidence of conformity, they should be appropriately accredited for the service provided (section 5.2)

Principle 9

Without appropriate evidence of product conformity, structural steels should not be used in building or infrastructure projects or be treated as unidentified steel (NZS 3404)

9.0 Conclusions

In response to the greater risk of non-compliant structural steels sourced through global procurement supply chains, SCNZ has developed a risk-based conformity assessment selection framework in collaboration with HERA. This risk-based approach accounts for project and supply risk.

The intent of publishing this Guide is to simplify and unify local practice for demonstrating conformity of structural steels.

This Guide complements other industry quality activities such as industry developed quality assurance programmes for Structural Steel Contractors (Steel Fabrication Certification scheme launched in 2014) and a Structural Steel Distributor Charter currently under development.

References

- APCC, Procurement of Construction Products – A Guide to Achieving Compliance, Australasian Procurement and Construction Council, 2015
- AS, General Principles on Reliability of Structures, AS 5104, Standards Australia, Sydney, 2005
- AS/NZS, Structural Design Actions – General Principles, Standards Australia/Standards New Zealand, Sydney/Wellington, 2002
- BSI, Steel for the Reinforcement of Concrete – Weldable Reinforcing Steel – Bar, Coil and Decoiled Product – Specification, BS 4449, British Standards Institution, London, 2005
- Fussell A., Cowie K., Hicks S. and Karpenko M., Ensuring the Compliance of Structural Steelwork Regardless of Origin, SESOC Journal Volume 29, No 1, April 2016
- Hicks S., Conformity of structural steel products and structures, SESOC Journal, Vol. 29, No 2, September 2016
- Hong Kong Constructional Metal Structures Association, Selection of Equivalent Steel Materials to European Steel Materials Specifications, Professional Guide HKCMSA – Pool, Hong Kong/Macau, 2015
- ISO/UNIDO, Conformity Assessment Toolbox, International Organisation for Standardization/ United Nations Industrial Development Organisation, Geneva, Switzerland, Vienna, Austria
- ISO, Conformity Assessment – Fundamentals of Product Certification, ISO 17067, International Organisation for Standardization, Geneva, Switzerland, 2013
- ISO, General Principles on Reliability of Structures, ISO 2394, International Organisation for Standardization, Geneva, Switzerland, 2015
- ISO, Statistical Sampling Methods for Quality Control of Building Materials and Components, ISO 12491, International Organisation for Standardization, Geneva, Switzerland, 1997
- SA/SNZ, Cold-formed structural hollow sections, AS/NZS 1163, Standards Australia/ Standards New Zealand, Sydney, Wellington, 2016
- SA/SNZ, Structural steel – Hot rolled plates, floor plates and slabs, AS/NZS 3678, Standards Australia/ Standards New Zealand, Sydney, Wellington, 2016
- SA/SNZ, Structural steel Part 1: Hot rolled bars and sections, AS/NZS 3679.1, Standards Australia/ Standards New Zealand, Sydney, Wellington, 2016
- SA/SNZ, Steel Reinforcing Material, AS/NZS 4671, Standards Australia/ Standards New Zealand, Sydney, Wellington, 2001
- SA/SNZ, Steel Prestressing Materials Testing Requirements, AS/NZS 4672.2, Standards Australia/ Standards New Zealand, Sydney, Wellington, 2007
- SA/SNZ, Structural Steelwork – Fabrication and Erection, AS/NZS 5131, Standards Australia/ Standards New Zealand, Sydney, Wellington, 2016
- SNZ, Steel Structures Standard, AS/NZS 3404, Standards New Zealand, Wellington, 1997 including amendments 1 & 2
- Singapore BCA, Design Guide on Use of Alternative Structural Steel to BS 5950 and Eurocode 3, BC 1, Singapore Building and Construction Authority, Singapore, 2012

Appendix A - List of AS/NZS Structural Steel Product Standards

AS/NZS 1594 Hot-rolled steel flat products

AS/NZS 1163 Cold-formed structural steel hollow sections

AS/NZS 3678 Structural Steels – Hot rolled plates, floor plates and slabs

AS/NZS 3679.1 Structural steel – Part 1: Hot rolled bars and sections

AS/NZS 3679.2 Structural steels – Part 2: Welded I sections

Appendix B - Conformity Assessment Pathway Selection Framework Diagrams

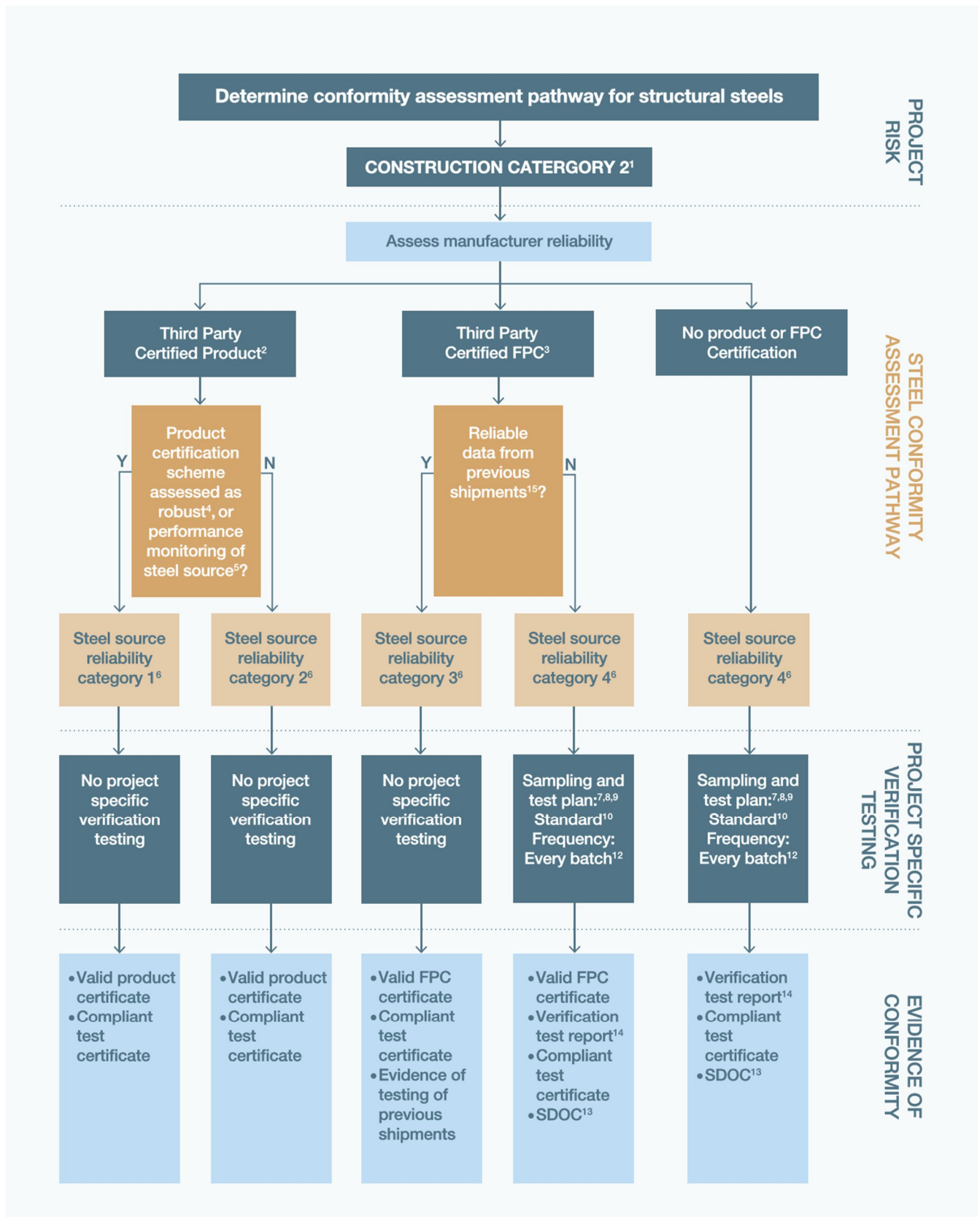


Figure 2 – Conformity Assessment Pathway Selection Framework – Construction Category 2 Projects or Components

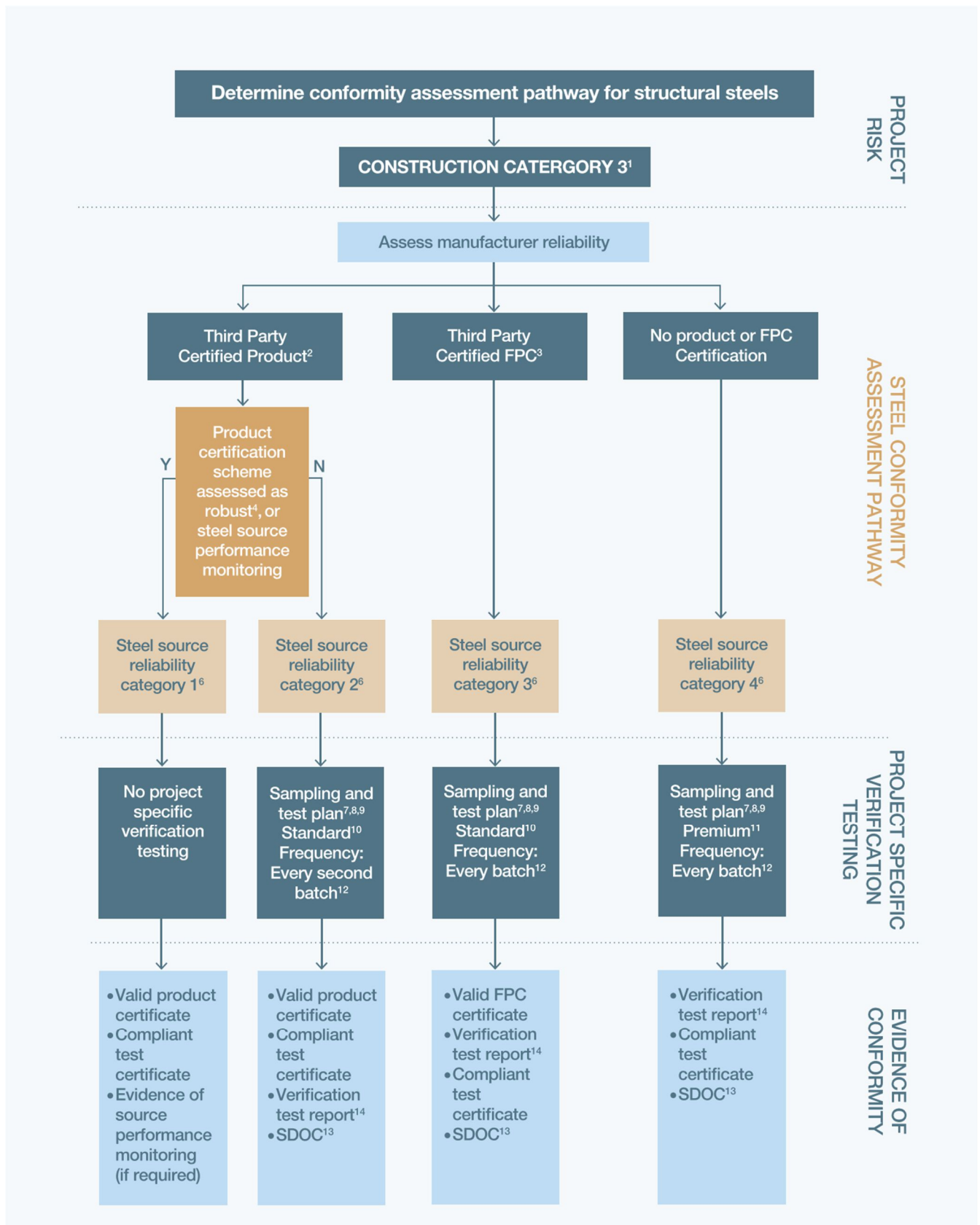


Figure 3 – Conformity Assessment Pathway Selection Framework – Construction Category 3 Projects or Components

Notes:

1. Construction category definitions as per AS/NZS 5131
2. Third-party product certification scheme operated by a CAB accredited by an International Accreditation Forum Multilateral Recognition Arrangement (IAF MLA) signatory
3. Manufacturer independently certified as meeting the FPC requirements of Appendix ZA of the appropriate EN Steel Supply Standard, or the requirements in the Singapore Construction Authority document BC1:2012
4. It is recommended the supplier engages a qualified metallurgist to assess the rigor of the product certification scheme
5. Recommended steel source performance monitoring requirements are presented in Appendix F, note 1
6. Source reliability categories are defined in Appendix F
7. Verification testing is to be undertaken at an independent test facility accredited by an ILAC Mutual Recognition Arrangement (ILAC MRA) signatory
8. For offshore project-specific verification testing, it is recommended duplicate samples are collected as per section 5.5.1
9. The collection of test samples must be undertaken by a trusted third party independent from the supplier and manufacturer
10. Sampling and testing plan (Standard) requirements are presented in Appendix D
11. Sampling and testing plan (Premium) requirements are presented in Appendix D
12. A batch of steel is defined as:
 - a. Hollow sections of the same size, nominal thickness, and grade manufactured from the same heat, tube forming process (tube mill) and rolling (rolling set up) (AS/NZS 1163)
 - b. A group of rolled sections or bars consisting of finished steel of the same yield stress gradation and product form (e.g. UB, UC, PFC etc), treated in the same manner and from the same heat (AS/NZS 3679.1)
 - c. A group of rolled parent plates consisting of finished steel of the same yield gradation and product form, treated in the same manner and from the same heat (AS/NZS 3678)
 - d. Welded sections
 - i. Plate material: The definition of 12. c. applies
 - ii. Flange to web tensile test: Welded beams of the same size, plate thicknesses and grade of steel. One test for each batch not exceeding 50 tonnes, 2 tests for batches greater than 50 tonnes.
13. SDOC: Supplier declaration of conformity
14. Recommended requirements for verification test reports are presented in Appendix D
15. Refer Appendix F, note 2 for recommended requirements for steel source test data from previous shipments

Appendix C - AS/NZS 5131 Construction Categories

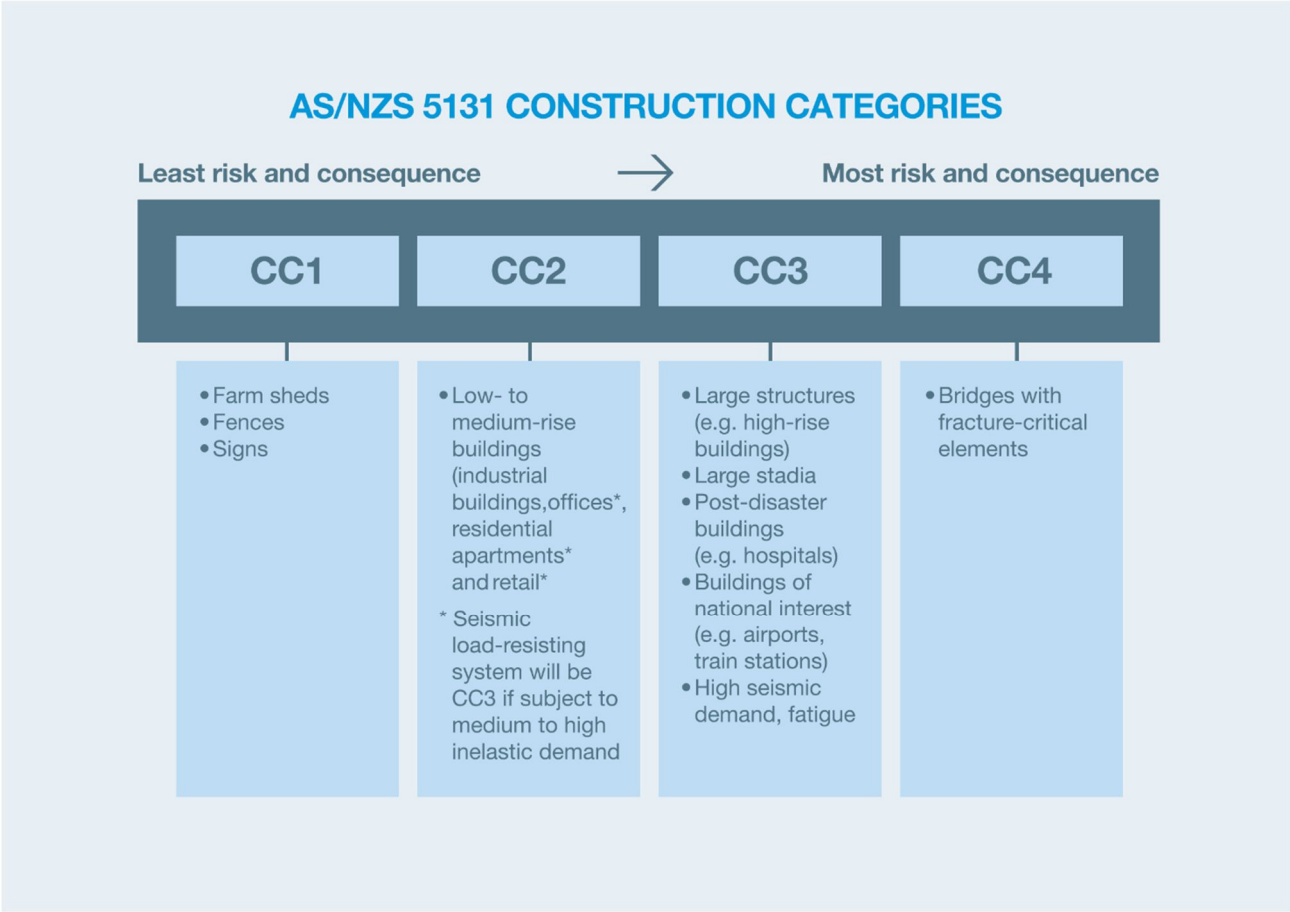


Figure C1 – Examples of construction categories for various types of structures.

Appendix D - Batch Testing and Inspection

D1 Introduction

The recommended verification testing focuses primarily on the mechanical and chemical properties of structural steels as these variables have a significant impact on their structural performance and weldability.

Chemical composition of the finished product should be determined in accordance with the AS/NZS 1050 series Standards or other procedures that achieve the same, or better, degree of accuracy. The product analysis should conform to the limits for chemical elements, including residual elements such as boron that should not be intentionally added to the steel without the agreement of the purchaser as required in the applicable product standard. Typically, the method of choice is spark OES (Optical Emission Spectrometry) as it allows for fast and accurate element analysis of solid metal samples.

The verification testing and inspections should be undertaken to the requirements of the relevant product standard. Any testing and inspection bodies engaged to undertake such activities shall be appropriately accredited.

D2 Sampling and Testing Plan

D2.1 Introduction

Two sampling and testing plans have been prepared for use in conjunction with the conformity assessment pathway selection approach proposed in this Guide. These plans are referred to as Standard and Premium.

The Standard plan features a non-statistical acceptance criterion for all material property testing and inspections, see table D1.

The Premium plan features a statistical sampling (inspection by variables) batch acceptance approach for material tensile properties (table D3) and a non-statistical acceptance criterion for the remaining properties (table D2).

D2.2 Sampling and Testing Plan (Standard)

Batch acceptance criterion: Non-statistical

Structural Steel product	Characteristic	Requirement	Sample Size	Acceptance No. (Ac)
Structural hollow section	Chemical composition	Product analysis	1	0
	Tolerance	Straightness	1	0
	Mechanical properties	Yield stress, tensile strength, elongation	1 ¹	0
		Impact toughness	3 ²	0
	Weld quality	Cold flattening	1 ¹	0
Plate	Chemical composition	Product analysis	1	0
	Mechanical properties	Yield stress, tensile strength, elongation	1 ³	0
		Impact Toughness	3 ²	0
		Reduction in area for through thickness properties	1	0
Hot rolled bars and sections	Chemical composition	Product analysis	1	0
	Tolerance	Out of straightness	1	0
	Mechanical properties	Yield stress, tensile strength, elongation	1 ¹	0
		Impact toughness	3 ²	0
Welded sections	Chemical composition	Product analysis	1	0
	Tolerance	Straightness	1	0
	Mechanical properties	Yield stress, tensile strength, elongation	1 ³	0
		Impact toughness	3 ²	0
	Weld quality	Web to flange tensile test	1 ³	0

Table D1 – Recommended Sampling and Testing Plan (Standard): Mechanical and geometric properties, chemical composition and weld quality

¹ One test for each batch not greater than 50 tonnes. Two tests for batches greater than 50 tonnes.

² As per product standard, typically 3 test samples for impact toughness testing

³ One test for each batch not greater than 70 tonnes. Two tests for batches greater than 70 tonnes.

D2.3 Sampling and Testing Plan (Premium)

Sampling and testing plan (Premium) features a statistical sampling (inspection by variables) acceptance criterion for tensile properties of structural steels, and a non-statistical acceptance criterion for the remaining properties of interest.

Batch acceptance criterion: Non-statistical

Structural Steel product	Characteristic	Requirement	Sample Size	Acceptance No. (Ac)
Structural hollow section	Chemical composition	Product analysis	1	0
	Tolerance	Straightness	1	0
	Mechanical properties	Impact toughness	3 ¹	0
	Weld quality	Cold flattening	1 ²	0
Plate	Chemical composition	Product analysis	1	0
	Mechanical properties	Impact toughness	3 ¹	0
		Reduction in area for through thickness properties	1	0
Hot-rolled bars and sections	Chemical composition	Product analysis	1	0
	Tolerance	Out of straightness	1	0
	Mechanical properties	Impact toughness	3 ¹	0
Welded sections	Chemical composition	Product analysis	1	0
	Tolerance	Straightness	1	0
	Mechanical properties	Impact toughness	3 ¹	0
	Weld quality	Web to flange tensile test	1 ³	0

Table D2 – Recommended Sampling and Testing Plan (Premium): Impact toughness, tolerance, chemical composition and weld quality

¹ As per product standard, typically three test samples for impact toughness testing

² One test for each batch not greater than 50 tonnes. Two tests for batches greater than 50 tonnes.

³ One test for each batch not greater than 70 tonnes. Two tests for batches greater than 70 tonnes.

Batch acceptance criterion: Statistical Sampling

Structural Steel product	Characteristic	Requirement	Sample Size	Acceptance Criterion
Structural hollow section	Mechanical properties	Yield stress, tensile strength, elongation	min 3 ¹	$\bar{X}_p - k \cdot s \geq L^1$ where \bar{X}_p = mean value of tests from batch s = standard deviation k = statistical multiplier (table E1) L = minimum value of property from product standard
Plate	Mechanical properties	Yield stress, tensile strength, elongation	min 3 ¹	
Hot-rolled bars and sections	Mechanical properties	Yield stress, tensile strength, elongation	min 3 ¹	
Welded sections	Mechanical properties	Yield stress, tensile strength, elongation	min 3 ¹	

Table D3 – Recommended Sampling and Testing Plan (Premium): Mechanical tensile properties

¹ Refer Appendix E for details of sampling inspection by variables methodology

D3 Non-Statistical Evaluation of Conformity

D3.1 Sampling, Testing and Assessment

Sampling, testing and assessment shall be undertaken in the following steps:

- a) Select samples at random from the batch of steel
- b) For each characteristic in table D1 or D2, carry out inspection or testing on the number of samples required
- c) Record the number of non-conforming characteristics and accept the batch if the number is less than or equal to the acceptance number (A_c)
- d) For any characteristic, if the number of non-conforming test results is greater than the acceptance number (A_c), the batch is rejected

D3.2 Retesting in Case of Non-Conforming Product

The proposed retesting requirement outlined below is based on that found in BS 4449 (BSI, 2005).

If any test specimen fails to meet the yield stress, tensile strength, yield/ tensile ratio, elongation, impact toughness, flange to web tensile (welded sections), cold flattening (structural hollow sections), or out of straightness requirements, four additional specimens shall be taken from the same batch to undergo tests. If all the additional four specimens pass the retests, the batch is deemed to conform to the standard. Otherwise the batch is deemed non-conforming.

D4 Statistical Sampling Batch Acceptance Criterion

Refer to Appendix E for a Statistical Sampling (inspection by variables) methodology for assessing the conformity of tensile properties of batches of steels.

D5 Traceability

The identification number of the batch shall be identified on the verification test report and on individual or bundled product.

D6 Test Report

A test report shall be prepared containing the following information:

- a) The manufacturer's name
- b) The section designation
- c) The grade of steel
- d) The date of testing
- e) The heat number
- f) Product marking
- g) Individual test results
- h) Computed minimum values (only applies if statistical sampling (inspection by variables) undertaken)

D7 Supplier Declaration of Conformity

A Supplier Declaration of Conformity (SDOC) shall be provided. The SDOC shall include the following:

- a) A statement from the supplier that the batch of structural steel covered by the SDOC complies with the mechanical and chemical properties, weld quality (only applicable for material steels to AS/NZS 1163 and 3679.2) and out of straightness requirements of the relevant product standard
- b) Reference verification test report or reports used to support claim of conformity

Appendix E - Statistical Sampling as a Means of Demonstrating Conformity

E1 Introduction

The international standard ISO 12491 (ISO, 1997) provides statistical methods for all types of building materials and components to ensure that they meet the quality control requirements given in ISO 2394 (ISO, 1988)/AS 5104 (AS, 2005), which forms the basis for AS/NZS 1170.0 (AS/NZS, 2002). The previous versions of the AS/NZS steel supply standards required steel mills to use a statistical sampling approach based on the ISO 12491 methods to demonstrate their statistically predicted proportion of non-conforming product is less than 5% at a 90% confidence level.

Sampling and testing plan (Premium) features a statistical sampling (inspection by variables) approach to assessing the conformity of the tensile properties of batches of steel. This covers the following mechanical properties:

- a) Tensile strength (f_u)
- b) Yield stress (f_y)
- c) Yield to tensile ratio (f_y/f_u)
- d) Elongation (A_{gt})

The statistical sampling (inspection by variables) methodology presented in this Guide is based on ISO 12491 (ISO, 1997)

Impact toughness, chemical composition, weld quality and out of straightness should be verified using the non-statistical evaluation of conformity approach proposed in table D2.

E2 Statistical Sampling (Inspection by Variables) Methodology

Extent of Sampling

A minimum of three test specimens shall be taken from each batch of steel. Additional numbers of samples may be taken if the computed minimum or maximum values do not comply with those specified in the product standard.

The preparation of test samples shall be as per the relevant structural steel manufacturing standard.

Properties to be Tested

- a) Yield stress (f_y)
- b) Tensile strength (f_u)
- c) Elongation (A_{gt})

Evaluation of Results

The minimum values of yield stress, tensile strength, elongation and the maximum value of f_y/f_u shall be computed as follows:

Step 1: Estimation of the mean and standard deviation of the test population

The mean value and standard deviation of the tests within the batch should be estimated using the following equations for \bar{X}_p and s , respectively:

$$\bar{X}_p = \sum x_s / n_p$$

$$s = \sqrt{\left[\sum (x_s - \bar{X}_p)^2 / (n_p - 1) \right]}$$

where x_s is the individual test value and n_p is the number of test values within the batch.

Step 2: Estimation of the nominal value from tests

The minimum or maximum value of a material property may be estimated from the following equations:

$\bar{X}_p - Ks \geq L$ for minimum nominal values (no individual test result less than the lower value specified in the product standard)

$\bar{X}_p + Ks \leq U$ for maximum nominal values (no individual test result greater than the upper value specified in the product standard)

where K is the statistical multiplying factor from Table E1 and L is the minimum or maximum value specified in the appropriate product standard.

Number of test values n_p	3	4	5	6	8	10	20	30	∞
For f_y ($p=0.95$ at 75% confidence level)	3.15	2.68	2.46	2.34	2.19	2.10	1.93	1.87	1.64
For A_{gt} , f_y/f_u ($p=0.90$ at 90% confidence level)	4.26	3.19	2.74	2.49	2.22	2.07	1.77	1.66	1.282

Table E1 - Statistical multiplication factor K

Example

Consider five tensile tests with measured upper yield strength values of $ReH = 365, 340, 355, 400$ and 395 MPa. From the above equations, the mean value $\bar{X}_p = 371$ MPa and the corresponding standard deviation $s = 25.84$ MPa. The estimated nominal value is therefore:

$$\bar{X}_p - Ks = 371 - (2.46 \times 25.84) = 307.4 \text{ MPa}$$

From AS/NZS 3679.1, the minimum yield stress value for Grade 300 yield stress for the material $ReH = 300$ MPa, for a thickness of between 11 and 17 mm. As the minimum value criteria is satisfied and no individual test values fall below the grade minimum, it is therefore concluded that the batch of steel complies with the minimum yield stress requirement for Grade 300 steel.

E3 Verification Test Report

Refer Appendix D.

E4 Supplier Declaration of Conformity

Refer Appendix D.

E5 Personnel Competency

The supplier shall engage a qualified metallurgist or materials engineer to undertake the calculations presented in section E2.

Appendix F - Source Reliability Categories

The recommended conformance assessment pathway selection framework requires steel sources to be categorised into one of four source reliability categories based on their quality risk. It is recommended a qualified metallurgist or materials engineer is engaged to undertake this source risk assessment. Such risk assessment must also consider the rigor of any third-party product scheme that is relied upon as independent verification of the claim by the manufacturer that their products comply with the relevant structural steel product standard.

The source reliability categories are as follows:

Source Reliability Category (SRC)	Manufacturer Certifications	Additional considerations
SRC 1	Product	Product certification scheme assessed as sufficiently rigorous to be relied on as sole basis for accepting steels for high risk projects or the supplier's performance monitoring of their steel source meets the minimum performance monitoring requirements of note 1
SRC 2		Product certification scheme assessed as not sufficiently rigorous to be relied upon as the sole basis for accepting steels for high-risk projects and the supplier has not undertaken performance monitoring of their steel source that meets the requirements of note 1
SRC 3	Factory Production Control	Has the supplier undertaken any previous testing of product from this manufacturer? If the answer is no, and the structural steel will be used for construction category 2 projects or components, see note 2
SRC 4	None	

Notes:

1. Performance monitoring is defined as a minimum of 30 tensile and chemical composition tests over the previous two years from a minimum of two shipments. Such testing shall be undertaken by appropriately accredited CABs.
2. If the steel is the first shipment from a manufacturer, or product from this source has not previously been third-party tested by the supplier, the material shall be batch tested as per sampling and test plan (standard) regardless of the project construction category. Thereafter the requirements applicable for a source reliability category 3 material will apply. The test data shall be from testing of structural steels of the same product form (e.g. PFC, UB, UC, structural hollow sections, plate), yield stress gradation and impact toughness requirements as those specified in the contract documents.

Appendix G - Implementation of Conformance Assessment Pathway Selection Framework

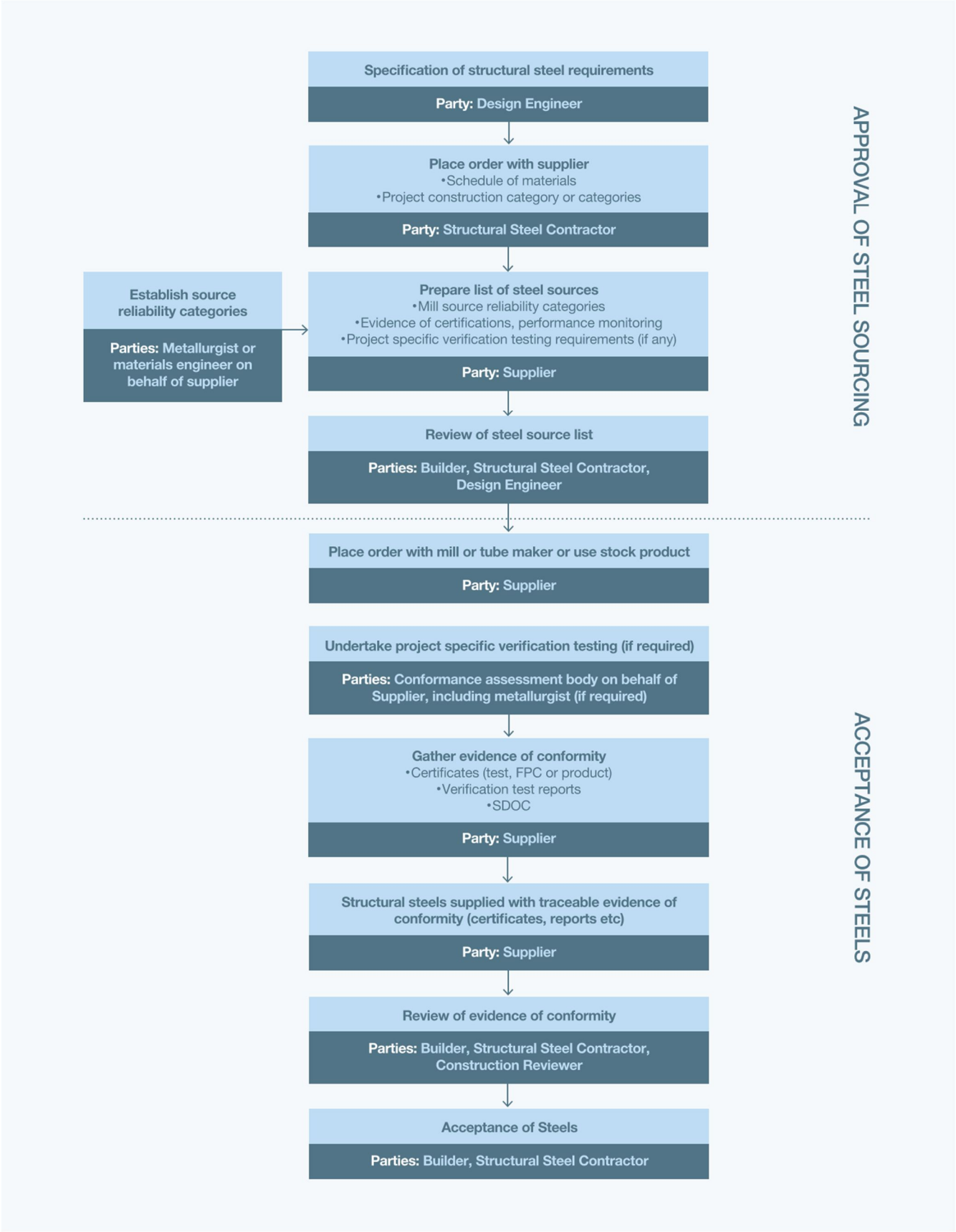


Figure G1 – Recommended implementation of conformance assessment pathway selection framework.

Appendix H - Determine evidence of conformity to accept batches of steel – Worked examples

Introduction

To illustrate the use of the conformity assessment pathway selection approach recommended in this Guide, two fictitious examples have been prepared.

The examples are:

1. A portal-framed warehouse
2. A high-rise office building located in a region of high seismicity

In both examples the same sources of steels are utilised to demonstrate how increasing the project risk can change the evidence required to accept batches of steel.

Example 1 – Portal-Framed Warehouse

Step 1: Assess the project risk (From AS/NZS 5131)

Construction category supplied in the contract documentation: CC2

Step 2: Metallurgist or Materials Engineer assessment of steel source risk (refer Appendix F)

Steel manufacturer	Manufacturer or product certification?	Comment	Source reliability category
1	Product	Certification scheme assessed as possessing sufficient rigor to provide independent verification of manufacturer's claim of conformity with product standard	1
2	Product	Certification scheme not assessed as possessing sufficient rigor to provide independent verification of manufacturer's claim of conformity with product standard, but supplier's third-party testing meets steel source performance monitoring requirements of Appendix F	1
3	Product	Certification scheme not assessed as possessing sufficient rigor to provide independent verification of manufacturer's claim of conformity with product standard. No steel source performance monitoring by supplier	2
4	Factory Production Control	Steels for project are the first shipment from the steel source	4
5	Factory Production Control	Regular source. The supplier has undertaken testing of product from this source previously	3
6	None		4

Step 3 – Assess whether project-specific testing is required (refer Appendix B and I)

Steel manufacturer	Source reliability category	Project specific verification testing required?	Sampling and test plan (refer Appendix D)	Frequency of batch testing
1	1	No	NA	NA
2	1	No	NA	NA
3	2	No	NA	NA
4	4	Yes	Standard	Every batch
5	3	No	NA	NA
6	4	Yes	Standard	Every batch

Step 4 – Determine evidence of conformity required (refer Appendix B and I)

Steel manufacturer	Source reliability category	Evidence of conformity required to accept batch of steel
1	1	Valid product certification certificate, compliant mill test certificate
2	1	Valid product certification certificate, compliant mill test certificate
3	2	Valid product certification certificate, compliant mill test certificate
4	4	Valid FPC certificate, test report, supplier declaration of conformity, compliant test certificate
5	3	Valid FPC certificate, compliant test certificate
6	4	Test report, supplier declaration of conformity, compliant test certificate

Example 2 – High-rise office building located in region of high seismicity

Step 1: Assess the project risk (From AS/NZS 5131)

Construction category supplied in the contract documentation: CC3

Step 2: Metallurgist or Materials Engineer assessment of steel source risk (refer Appendix F)

Steel manufacturer	Manufacturer or product certification?	Comment	Source reliability category
1	Product	Certification scheme assessed as possessing sufficient rigor to provide independent verification of manufacturer's claim of conformity with product standard	1
2	Product	Certification scheme not assessed as possessing sufficient rigor to provide independent verification of manufacturer's claim of conformity with product standard, but supplier's third-party testing meets steel source performance monitoring requirement of Appendix F	1
3	Product	Certification scheme not assessed as possessing sufficient rigor to provide independent verification of manufacturer's claim of conformity with product standard. No steel source performance monitoring by supplier	2
4	Factory Production Control	Steels for project are the first shipment from the steel source	3

5	Factory Production Control	Regular source	3
6	None		4

Step 3 – Assess whether project-specific testing is required (refer Appendix B and I)

Steel manufacturer	Source reliability category	Project-specific verification testing?	Sampling and test plan (refer Appendix D)	Frequency of batch testing
1	1	No	NA	NA
2	1	No	NA	NA
3	2	Yes	Standard	Every second batch
4	3	Yes	Standard	Every batch
5	3	Yes	Standard	Every batch
6	4	Yes	Premium	Every batch

Step 4 – Determine evidence of conformity required (refer Appendix B and I)

Steel manufacturer	Source reliability category	Evidence of conformity required to accept batch of steel
1	1	Valid product certification certificate, compliant mill test certificate
2	1	Valid product certification certificate, compliant mill test certificate, evidence of performance monitoring
3	2	Valid product certification certificate, compliant mill test certificate, test report, supplier declaration of conformity
4	3	Valid FPC certificate, test report, supplier declaration of conformity, compliant test certificate
5	3	Valid FPC certificate, test report, supplier declaration of conformity, compliant test certificate
6	4	Test report, supplier declaration of conformity, compliant test certificate

Appendix I - Summary of Recommended Source Reliability Conformity Requirements

Construction Category 2 project or components

Source reliability category	Project-specific verification testing	Sampling and testing plan	Frequency of testing	Evidence of conformity
1	Not required	NA	NA	Valid product certificate, compliant test certificate
2	Not required	NA	NA	Valid product certificate, compliant test certificate
3	Not required	NA	NA	Valid FPC certificate, compliant test certificate
4	Required	Standard	Every batch	Verification test report, compliant test certificate, supplier declaration of conformity

Construction Category 3 project or components

Source reliability category	Project-specific verification testing	Sampling and testing plan	Frequency of testing	Evidence of conformity
1	Not required	NA	NA	Valid product certificate, compliant test certificate
2	Required	Standard	Every second batch	Valid product certificate, compliant test certificate, verification test report, supplier declaration of conformity
3	Required	Standard	Every batch	Valid FPC certificate, compliant test certificate, verification test report, supplier declaration of conformity
4	Required	Premium	Every batch	Verification test report including results of statistical sampling (inspection by variables), compliant test certificate, supplier declaration of conformity

HERA

Hera House, 17-19 Gladding Place
Manukau City 2104, New Zealand
Phone: +64 9 262 2885, Fax: +64 9 262 2856
Email: admin@hera.org.nz
www.hera.org.nz

STEEL CONSTRUCTION NEW ZEALAND INC.

L2, 17-19 Gladding Place
P.O. Box 76403, Manukau City 2241, New Zealand
Phone: +64 9 263 5635, Fax: +64 9 263 5638
Email: info@scnz.org
www.scnz.org

